



## Original Communication

## Determination of adolescent ages 14–16 years by radiological study of permanent mandibular second molars

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## ABSTRACT

This study was conducted to determine the adolescent ages from 14 to 16 years, from dental radiographic study of the closure of apical foramen of permanent second molars. The sample for this study consisted of 116 students (59 males and 57 females) of age range from 13 to 18 years, from South Indian population, from various schools in and around Manipal, Karnataka, India. Here Demirjian method was applied on children of Manipal, where 94.0% of males presented with closed apical foramen at 15 years and 5 months where as 95.0% of female presented with closed apical foramen at 14 years and 9 months.

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## 1. Introduction

Accurate determination of age of a person is important in matters concerning medicine and law. The word 'Adolescent' literally means 'passing from childhood to maturity' and for all practical purposes it is the period extending from age 13 years to 17 years. However, among these, ages of 14 and 16 years are considered extremely important in routine medico-legal practices as they are more decisive in matters (civil or criminal) concerning factory employment, juvenile delinquency, sexual offences, kidnapping, etc.<sup>1–4</sup>

It is true that the courts all over the world have accepted parameters such as pubertal changes, progress in skeletal ossification, time of eruption of teeth etc as matchless scientific evidence in deciding controversies in adolescent age determination. However, these parameters at their best can tend to fix the age of the person (either live or dead) only at a near approximate range and not the exact age. This necessitates the need of further research in procuring newer techniques and date which can render opinion on exact age of victim or assailant, in deciding the nature of offence or fixing punishment especially in the adolescent age group range.

Recent advances in Forensic Odontology have contributed an immensely significant role in establishing accurate age.

The difficulty of deciding the age of majority in a person in whom the third molar has not erupted/partially erupted (eruption age range being 17–25 years) is no more a mystery with the recent advances in radiological study of development of crown, root and closure of apical foramina of the said tooth.<sup>5–7</sup> Studies in the eastern part of the world especially with reference to India is undoubtedly a paucity on account of several factors, the most glaring fact being the 'Forensic Odontology' is still in its infancy in India.

An attempt is made in the present study to determine the adolescent ages 14 and 16 years by radiological study of the development of crown, root and closure of apical foramina of permanent second molars which as reported in literature has a close relationship to the adolescent age period.<sup>2–4</sup>

However a pilot study was undertaken initially as through search in literature revealed no such work reported from any part of the world.

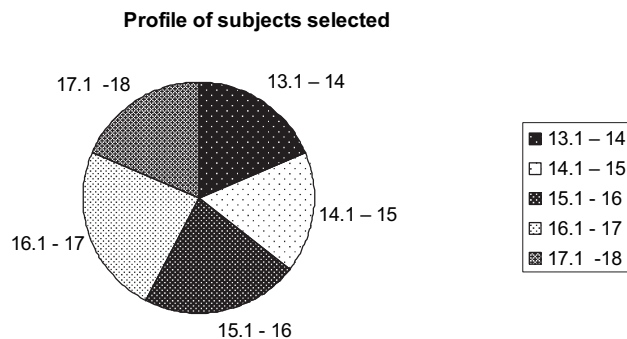
The results of this study being highly encouraging instigate a further exploration quantitatively as well as qualitatively with more number of cases to obtain higher degree of accuracy in reporting the exact age.

## 2. Materials and methods

The study was conducted on South Indian population, comprising of all the three major communities namely Hindus, Muslims and Christians, a total of 116 students (59 males and 57 females) of age range 13–18 years, were included in the study, chosen from the

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13.

1 – 14 years – 22 cases, 14.1 – 15 years – 21 cases, 15.1 – 16 years – 24 cases, 16.1 – 17 years – 26 cases, 17.1 – 18 years – 23 cases  
(Total number of cases -116)

**Fig. 1.** Breakdown analysis of study participants.

various schools in and around Manipal, the criteria for selection of each one being:

1. She/he must be a domicile of Manipal or any village, town or city of South Indian origin.
2. Has a proper document to certify the age stated.
3. Has a healthy oral hygiene and permanent second molars, erupted completely in the lower jaw on both sides.
4. Voluntarily consenting for the study procedures.

In order to locate the earliest age of closure of apical foramina, the subjects selected were categorized into 5 groups of assorted age at an interval of 12 months. Thus 18.97% of the subjects selected were in the age group of 13.1–14 years, 18.10% between 14.1 and 15 years, 20.70% between 15.1 and 16 years, 22.41% between 16.1–17 years and 17.1–18 years comprised 19.82% of the total number of cases.

Fig. 1 and Table 1 provides a breakdown analysis of the total subjects in the study.

Radiographs of lower right and left mandibular permanent second molars were then taken by two separate exposures, from each of the participants.

## 2.1. Intra oral radiography procedures<sup>8,11,15</sup>

### 2.1.1. The equipments

The radiographs were taken using Heliodont Seimens X-ray machine and Kodak Super Soft packet X-ray films.

**Table 1**  
Breakdown analysis of the study population.

Age group in years	No. of cases		Total	Percentage
	Male	Female		
13.1–14	11	11	22	18.97
14.1–15	10	11	21	18.10
15.1–16	13	11	24	20.70
16.1–17	14	12	26	22.41
17.1–18	11	12	23	19.82
Total	59	57	116	100%

Radiographs of lower right and left mandibular permanent second molars were then taken by two separate exposures, from each of the participants, in the Department of Oral Diagnosis, Medicine and Radiology, College of Dental Surgery, Manipal, DK, Karnataka.

### 2.1.2. Studying the X-ray

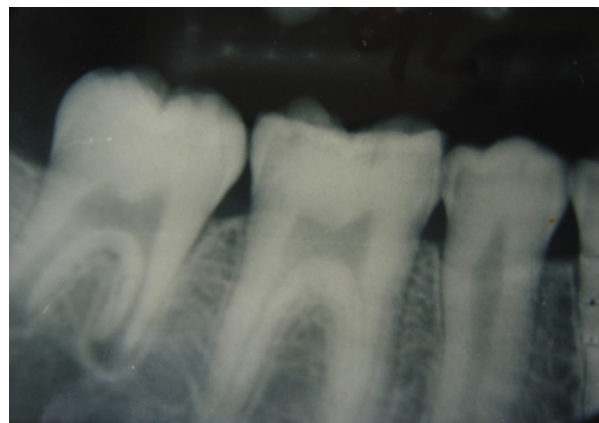
Each of these X-ray films were then studied for root development and apical foramina closure, using a magnifying lens fitted in a Rinn X-ray viewer.

### 2.2. Criteria for complete root formation and apical closure

The criteria for assessment of complete root formation and apical closure was adopted from the description of dental formation stages by 'Demirjian et al.'<sup>8,11,15</sup> Figs. 2 and 3 are photo radiographs which illustrate patent and closed apical formation respectively. As the roots were completely formed in majority of the cases studied (99%), the specific age determination was restricted to the final stage i.e., "stage-H" by Demirjian et al.<sup>8,11,15</sup> of root development i.e., apical closure only.

The experimental error and bias of assessing the apical closure was minimized by studying each radiograph by two separate observers independently. Whenever there was a difference of opinion expressed, the particular radiograph was studied jointly by both observers and a common opinion sought.

Based on the details observed it is a fact that the exact age at which the maximum number of apical foramina closure occurred in the present study was 15 years 4 months and 14 years 9 months in male and female participants respectively. The percentage accuracy



**Fig. 2.** Apical foramen open.

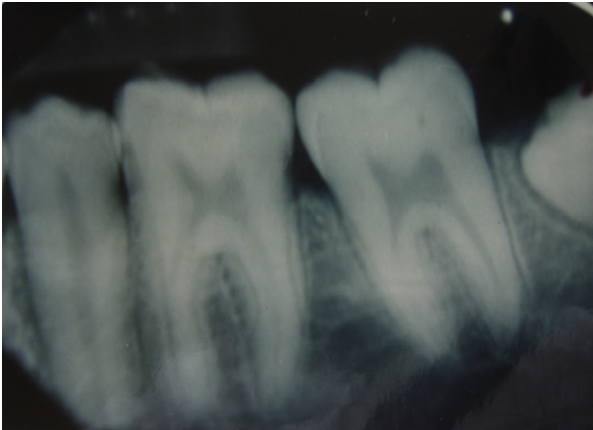


Fig. 3. Apical foramen close.

was then reported depending on, presence or absence of closure of the apical foramina in both sexes and tabulated in Tables 2 and 3.

Facts and figures of Tables 2 and 3 present a fairly high degree of accuracy of the methodology adopted. Thus all those male participants in whom the apical foramina is closed, are opined to be of age more than 15 years 4 months with an accuracy of 94.0% (Table 2) is highly significant.

Similarly all those female participants who showed a closed apical foramen in the present study can be opined to be of age more than 14 years with an accuracy of 97.4% (Table 3) is also considered as highly significant.

It is also true, that maximum age at which the apical foramen was found to be not closed (patent) was 15 years 11 months. Keeping this in mind while reporting the age by permanent second mandibular molar radiographs one can also infer that if the foramen is not closed precise age of the person is below 16 years (Figs. 4 and 5).

### 3. Discussion

Medical evidence on age is though not like an 'eye witness', is an opinion based on scientific reasoning and is hence insisted by court of law in confirming the age of a person involved in civil or criminal matters prior to the decision of the crime or fixing its punishment.<sup>1</sup>

Traditionally, the forensic experts in opining the age of a person depend on multiple objective and subjective variables, such as assessment of height, weight, pubertal changes, spacing of jaw etc.<sup>2–4</sup>, and express it in a range (within which the actual age could possibly be placed) and not as a precise age. Accordingly, the subject has been studied repeatedly and extensively.

The ages of 7, 10, 12, 14, 16, 18 and 21 years considered to be important with legal implications routinely. Of these the ages 14 and 16 years are of particular importance with reference to adolescent population.

It is a fact that, there are a number of reliable parameters to estimate the age up to 12 years. They include tooth eruption, X-ray of wrist

Table 2

Percentage accuracy of reporting the accurate age by radiological study of closure of apical foramen impermanent mandibular second molars in males.

Age	Total cases studied n (%)	Apical foramen status	
		Open n (%)	Closed n (%)
<15 years 4 months	26 [44.1]	24 [92.3]	2 [6.0]
>15 years 4 months	33 [55.9]	2 [7.7]	31 [94.0]
Total	59 [100%]	26 [100%]	33 [100%]

Table 3

Percentage accuracy of reporting the accurate age by radiological study of closure of apical foramen in permanent mandibular second molars in females.

Age	Total cases studied n (%)	Apical foramen status	
		Open n (%)	Closed n (%)
<14 years 9 months	18 [31.6]	16 [94.1]	2 [5.0]
>14 years 9 months	39 [68.4]	1 [5.9]	38 [95.0]
Total	57 [100%]	17 [100%]	40 [100%]

Percentage of Presence or Absence of Closure of Apical Foramen For Males:

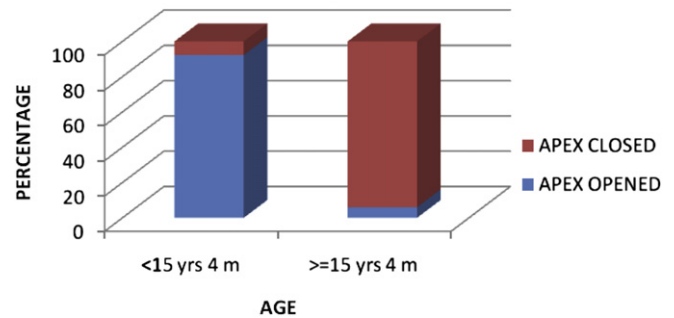


Fig. 4. Percentage of presence or absence of closure of apical foramen for males.

and elbow etc.<sup>2,3</sup> For ages above 18, X-rays of shoulders joint, hip joint, knee joint and even the spacing and eruption of the last molar tooth are the reliable parameters.<sup>2,3</sup> The medico legally important ages of 14 and 16 years have ironically lesser reliable parameters.

The fact that, the permanent mandibular second molars erupt between 12 and 14 years and completes their root development by 14–16 years<sup>2,3,6</sup> makes it suitably chosen as 'key tooth' in determining the adolescent ages 14 and 16 years in the present study.

In the present study the earliest closure of apical foramen in male was though observed at 15 years, the age wherein maximum no. of cases showed the apical foramen closure was from 15 years 4 months.

Hence it is inferred that in a given dental X-ray if the permanent mandibular second molar shows closure of the apical foramen the girl in question can be opined as more than 14 years. From this study, it is evident that not a single case is there, where apical foramen is open after 16 years of age.

Thus the study has though profoundly convinced the fact that the methodology is fairly accurate in establishing the adolescent ages of 14–16 years, needs further research involving more number of subjects of either sex prior to its total acceptance in routine practices.

Percentage of Presence or Absence of Closure of Apical Foramen For Females:

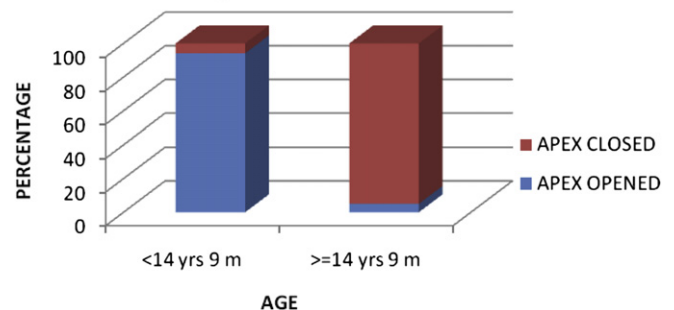


Fig. 5. Percentage of presence or absence of closure of apical foramen for females.

The effect of race, environmental factors, nutritional status and pathology of teeth, are yet other directions, which might allow variations in the accuracy reported, needs certainly further studies to give a definite opinion.

However, with all these facts, the methodology described in the study still stands prominent for all its simplicity in the conduct and inferring the opinions, requiring no special training or expertise technically merits acceptance in routine medico-legal practice.

#### 4. Summary and conclusion

Determination of adolescent ages 14 and 16 years by radiological assessment of permanent mandibular second molars has been attempted in this preliminary study. The reasons being the said tooth erupts and completes its development during the period 12 years to 16 years, which is well within the range of adolescent period.

A total number of 59 boys and 57 girls of age range 13–18 years from various schools in and around Manipal were included in the study adopting Demirjian et al.<sup>8–11,15</sup> method, which was though devised for studying the third molars,<sup>12–17</sup> it was adopted for the present study on second molars for two reasons:

1. Basic principles of root development from the stage of its formation till the apical closure stands uniform among all permanent dentitions.
2. There is a paucity of literature on similar studies in India as well as other parts of the world.

Results of the study concluded following facts:

1. 94.0% of males presented with closed apical foramen at 15 years 5 months, the maximum possible age of patency being 17 years.
2. 95.0% of females presented with closed apical foramen at 14 years 9 months, the maximum possible age of patency being 15 years 11 months.
3. Thus if the given radiograph shows
  - a. A closed apical foramen the age can be firmly opined as more than 15 years in a male and more than 14 years in a female.
  - b. A patent (open) apical foramen the age can be firmly opined as less than 16 years in females and less than 17 years in a male.
4. The method opted is simple and requires no specialist training.
5. The procedure throws a new hope in determining the ages: 14 and 16 years precisely by using single parameter (i.e. radiographic evidence of closure of apical foramen of the roots) unlike the existing traditional methodologies wherein more than one parameters are utilized.

This study requires further exploration quantitatively as well as qualitatively with more number of cases to obtain higher degree of accuracy in reporting the exact age.

#### Conflict of interest

None declared.

#### Funding

None declared.

#### Ethical approval

None declared.

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